**Differential Equations involving more difficult manipulation**

**A) Formulating the equation from a statement**

Example: Winston is a small town in Southland which has been diminishing in size for some years. The Town Council has the data from the last census figures as shown to 3 sf in the table below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | 1991 | 1996 | 2001 | 2006 |
| **Population** | 2470 | 2350 | 2230 | 2120 |

The council believes that the rate of population decline is proportional to the size of the population itself, and wants to use this theory as a way of predicting the town’s population in 2015 for purposes of council decision-making.

Using the data as a way of forming an appropriate equation for the council’s theory, predict the Winston population in 2015.

From the council’s theory: (general solution)

* To find the constant , substitute in one set of points:

When :

The equation is now

* To find the constant , substitute in another set of points:

When : (this is for year 1996, with reference to 1991 being )

(3dp)

The equation is now

The equation should be tested on the other 2 set of the figures to check that it holds. (3sf) and (3sf) which is a little out but close enough to accept the equation for the intended purposes:

The prediction for the population of Winton in 2015 would be:

(3sf)

**B) When separation of variables is not straightforward**

Example: Solve the equation

(make the subject)

(take out common factor )

(separate the variables)

(integrate)

(replace old constant with new constant as value changes)

(replace the constant with the constant )